SYNOPSIS

Ph.D in Education

EFFECTIVENESS OF VEDIC MATHEMATICS-BASED INSTRUCTION ON ACHIEVEMENT IN MATHEMATICS AND ATTITUDE TOWARDS LEARNING MATHEMATICS AMONG PRIMARY AND UPPER PRIMARY STUDENTS

Submitted By

YOGESHWARI. S

(Reg No: 16PHEDP003)

Supervisor

Dr. H. INDU

Professor & Dean

School of Education

Submitted to

Avinashilingam Institute for Home Science and Higher Education for Women

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INTRODUCTION

Education plays a vital role in shaping a child's overall development, fostering intellectual, emotional, and practical skills. Through ongoing interaction with their environment, children not only acquire knowledge but also develop individuality and independence. A well-structured education system aims to nurture these abilities, offering opportunities for students to explore their interests and express their uniqueness. Education promotes critical thinking, problem-solving, and informed decision-making and helps children grow into self-reliant and well-rounded individuals.

The National Education Policy (NEP) 2020 of India emphasizes a conceptual approach to teaching mathematics, moving away from rote memorization. Recognizing mathematics as essential for logical reasoning and scientific temper, NEP 2020 advocates for interactive, enjoyable, and application-based learning. To enhance this approach, the policy incorporates India's rich cultural heritage through the integration of Indian Knowledge Systems (IKS). IKS focuses on traditional learning methods and wisdom, blending them with modern education to foster a deeper connection with India's cultural and intellectual legacy. In mathematics, this includes recognizing and applying ancient Indian methods, such as Vedic Mathematics, to enrich learning experiences.

Vedic Mathematics, known for its emphasis on mental computation and intuitive problem-solving, can significantly reduce math anxiety and make learning more engaging. By integrating IKS with modern pedagogies, NEP 2020 aims to create a balanced and holistic learning environment. This approach not only strengthens students' understanding of mathematical concepts but also connects them with traditional Indian wisdom, fostering both academic excellence and cultural pride. Through this innovative blend, NEP 2020 prepares students for future challenges while grounding them in India's rich intellectual heritage.

IMPORTANCE OF VEDIC MATHEMATICS

Vedic Mathematics refers to the ancient system of mathematics, rediscovered by Sri Bharati Krishna Tirthaji between 1911 and 1918. Tirthaji’s work revealed that all mathematical calculations could be simplified using 16 sutras and 13 sub-sutras. These sutras cover various branches of mathematics, from arithmetic to algebra and geometry. Compared to traditional methods, Vedic Mathematics is faster, more efficient, and encourages innovation in problem-solving. It offers flexibility, allowing learners to choose different methods, which keeps their minds active and engaged. This approach not only simplifies

complex calculations but also reduces math anxiety, making the subject more enjoyable and accessible to students.

One of the key benefits of Vedic Mathematics is its ability to enhance mental abilities. The coherence and interrelated nature of the system enables learners to develop clarity of thought and intuition. The sutras provide unique methods for solving complex problems quickly and accurately, engaging higher-order brain functions. Teaching Vedic Mathematics can significantly improve a child's mathematical ability, enabling them to solve problems with greater speed and precision. By integrating this approach into education, students are likely to develop a higher level of proficiency in mathematics, ultimately fostering a deeper appreciation and mastery of the subject.

STATEMENT OF THE PROBLEM

The cognizance of the importance of teaching mathematics in a trouble-free path has accelerated the investigator to take the investigation entitled 'Effectiveness of Vedic mathematics-based instruction on achievement in mathematics and attitude towards learning mathematics among primary and upper primary students.' This investigation is an endeavour to assess the effectiveness of Vedic mathematics on achievement in mathematics and attitude towards learning mathematics of students of VIII and III grade.

OPERATIONAL DEFINITION OF KEY TERMS

The key terms used in the study are Vedic mathematics-based instruction, Attitude towards learning mathematics, Achievement in mathematics, and Primary and Upper primary students. Apart from the terms used in the title of the study, the investigator also tried to find out the effect of Vedic mathematics-based instruction on Computation speed and attempted to analyse whether Learning style influences the use of Vedic mathematics. The key terms are explained:

VEDIC MATHEMATICS-BASED INSTRUCTION

Vedic mathematics refers to the mathematics system that prevailed in the ancient period. Sri Bharati Krishna Tirthaji (1884-1960) rediscovered this system from the Vedas during 1911-1918, based on sixteen sutras and thirteen sub-sutras.

In this study, five Sutras and one Sub-sutra were used to teach arithmetic skills to the students.

The Sankalanam Sutra simplifies addition by aligning place values by using dot addition. For subtraction, the Nikhilam Navatashcaramam Dashatah Sutra ("All from 9 and

the last from 10") streamlines subtraction by using vinculum numbers. The Urdhva Tiryagbhyam Sutra ("Vertically and crosswise") offers a fast, structured multiplication method that multiplies digits vertically and crosswise. For division, the Nikhilam Sutra applies complementary subtraction for divisors near the base, while the Paravarthya Sutra ("Transpose and apply") aids in simplifying more complex divisions. For squaring numbers, the Ekadhikena Purvena Sutra is used, and the Vilokanam Sub-Sutra helps in efficiently finding square and cube roots.

ATTITUDE TOWARDS LEARNING MATHEMATICS

Thurstone (1949) defines, "An attitude is the degree of positive or negative aspect associated with a psychological object." According to Hart (1989), the "attitude of an individual towards mathematics is defined as the emotions that he/she associates with mathematics (either positive or negative) by the individual's beliefs towards mathematics, and by how he/she behaves."

In the context of this study, Attitude toward learning mathematics specifically pertains to the extent to which students express their enthusiasm and willingness to learn mathematics and is assed with the Attitude toward learning mathematics scale.

PRIMARY AND UPPER-PRIMARY STUDENTS

The terms Primary and Upper Primary refer to different stages of education, typically in the school system. Upper Primary includes Grades VI to VIII and the age range of students is from 11 to 14 and Primary includes grades from I to V and the age ranges from 6 to 10 (National Curriculum framework, 2005).

This study focuses on students in the eighth and third grades, as fundamental mathematical operations such as addition, subtraction, and particularly multiplication are introduced in the third grade. The eighth grade represents an upper primary level, where a solid foundation in all algebraic operations is established to facilitate further advanced mathematical education.

ACHIEVEMENT IN MATHEMATICS

"Achievement in Mathematics refers to the extent to which a person has acquired certain mathematical skills or knowledge through instruction or practice." Lindquist (1967).

Here the scores obtained in the achievement test constructed and validated by the investigator is considered to be the achievement in mathematics.

LEARNING STYLE

"The particular set of cognitive, affective, and psychological behaviours that determine how individuals perceive, interact with, and respond to the learning environment." is defined as Leaning Style- Kolb (1984).

Learning style is a way that a person adopts to understand a particular situation, any concept, or a formula and it may differ from individual to individual. In this study, the learning styles namely Visual, Auditory, and Kinesthetics are considered. Visual learners are learners who learn through sight. Visual learners will understand better when shown things in maps, diagrams, and pictures. Auditory learners usually learn by the mode of hearing. They find learning better when they hear concepts either in the classroom or through gadgets. Kinesthetic learners experience and learn things by doing.

COMPUTATIONAL SPEED

Computational Speed refers to "the time complexity of an algorithm, which is a measure of the time required to execute an algorithm as a function of the input size." Thomas H. Cormen et al. (2009).

In this study, computational speed refers to the speed involved in the calculation of mathematical problems using Vedic mathematics.

OBJECTIVES OF THE STUDY

Objectives of this study are categorized under three heads:

Development and Validation

- To construct and validate a package for Vedic Mathematics-based instruction (VMPBMO).
- To develop and validate a Previous knowledge test and Achievement test in Mathematics.
- To construct and validate a rating scale on Attitude towards learning Mathematics.
- To develop and validate a Learning Style Inventory.

Relationship Analysis

- To find out the relationship between Achievement in Mathematics and Attitude towards learning Mathematics of Eighth-grade students and Third-grade students.

Comparative Analysis

- To compare the effectiveness of Vedic Mathematics-based instruction on Achievement in Mathematics and Attitude towards learning Mathematics of both Eighth-grade students and Third-grade students and also with respect to gender and type of school.

- To analyze which categories of learners, achieve better scores in achievement test from instruction based on Vedic Mathematics.
- To compare the computing speed of students taught by Vedic Mathematics-based instruction and traditional methods of teaching.

HYPOTHESES

- There is no significant difference in the Achievement in Mathematics and Attitude towards learning Mathematics of eighth-grade and third-grade students taught by Vedic Mathematics-based instruction and the Traditional methods of teaching.
- There will not be any significant relation between Achievement in Mathematics and Attitude towards learning Mathematics of eighth-grade and third-grade students taught by Vedic Mathematics-based instruction.
- There is no significant difference in the Achievement in Mathematics and Attitude towards learning Mathematics of eighth-grade and third-grade students taught by Vedic mathematics-based instruction based on Gender and Type of school.
- There is no significant difference in the Achievement in Mathematics of eighth-grade and third-grade students taught by Vedic Mathematics-based instruction based on their Learning style
- There will not be any significant difference in the computing speed of students taught by Vedic Mathematics-based instruction and traditional methods of teaching.

METHODOLOGY

METHOD USED IN THE PRESENT STUDY:

The experimental method is chosen for the present study. An experiment is a procedure carried out to support, refute, or validate a hypothesis. Experiments allow for precise control of variables; it can be replicated. In the experimental method, researchers identify and define key variables, formulate a hypothesis, manipulate the variables, and collect data on the results. The data obtained through experiments are quantitative data that can be analysed using inferential statistical tests.

INDEPENDENT AND DEPENDENT VARIABLES

Independent variable: Vedic Mathematics based instruction and Traditional methods of teaching mathematics

Dependent variable: Achievement in mathematics, Attitude towards learning mathematics, computational speed.

Moderator variable: learning style.

EXPERIMENTAL DESIGN

Pre-test- Post-test Control group Design was used to find the effectiveness of Vedic mathematics-based instruction on achievement in mathematics, attitude towards learning mathematics, learning style, and computational speed of third and eighth-grade students. Students were assigned randomly to both groups, the experimental and the control group. The experimental group was taught through Vedic mathematics-based instruction and the control group was taught mathematics in the traditional methods namely the Active Learning method (ALM) for VIII grade and Activity Based Learning (ABL) for third grade. The experimental group and the control group under study were subjected to a pretest before the intervention and a post-test after the intervention.

LOCALE AND SAMPLE OF THE STUDY

The locale of the study was Gudalur in the Nilgiris district of Tamil Nadu, India. The study was conducted on 360 samples of which 160 samples were taken from VIII grade and 160 samples from III grade. These 160 samples were further divided into 80 control and 80 experimental groups each. The investigator selected three schools namely St Mary's High School, St Mary's Primary School, and St Thomas Higher Secondary School for the intervention of which St Thomas Higher Secondary School is a private school and St Mary's High School and St Mary's Primary School are government-aided schools.

The researcher intended to find the effectiveness of Vedic mathematics-based instruction on the achievement in mathematics and attitude towards learning mathematics. First, it was decided to conduct the study on eighth-grade government-aided and private school students. Schools were selected and after getting permission, a pretest was conducted for both the experimental and control group students. Vedic mathematics-based instruction was taught for the experimental group and mathematics was taught in the traditional method namely ALM for VIII grade for the control group. After the intervention, a post-test was conducted and the data were collected. The collected data was scored and consolidated and on analyzing the data, it was found to be not significant. This made the investigator conduct the study for a smaller grade thinking that when students are in their formative stage a new methodology may work better and hence selected third-grade government-aided and private

school students and the study was conducted with a sample size of 160 students from third-grade.

CRITERIA FOR SELECTION OF CONTENT

As Vedic mathematics was new to the students of both eighth and third grade, it was necessary to teach them from basics and thereby basic arithmetic operations, and a few concepts such as square root, cube root, squaring, and algebraic multiplication were planned to be included in the package. For eighth grade, along with basic arithmetic operations, square root, cube root, squaring, and algebraic multiplication were taught in both traditional and Vedic methods. For third grade, as they are at the primary level only basic arithmetic operations namely addition, subtraction, and multiplication were taught in both traditional and Vedic methods for control and experimental groups respectively. The content was taken from the eighth and third grades of the State Board syllabus of Tamilnadu.

THE TOOL

Tools help in obtaining all the information required for achieving the research objectives. The tools used for the present study are:

- Previous knowledge test on mathematics for eighth grade (Constructed and validated by S.Yogeshwari and Indu. H,2018) and third grade (Constructed and validated by S.Yogeshwari and Indu. H,2019).
- Instructional package on Vedic mathematics for third and eighth grade (Prepared and validated by S.Yogeshwari and Indu. H 2018,2019)
- Lesson Transcripts based on Vedic mathematics for third and eighth grade (Prepared by S.Yogeshwari and Indu. H, 2018,2019)
- Lesson Transcripts based on Active Learning Methodology for eighth grade and Activity-Based Learning Method for third grade (Prepared by S.Yogeshwari and Indu. H, 2018, 2019)
- Achievement test in mathematics for eighth grade (Constructed and validated by S.Yogeshwari and Indu. H, 2018).
- Achievement test in mathematics for third grade (Constructed and validated by S.Yogeshwari and Indu. H, 2019).
- Attitude towards learning Mathematics scale for eighth grade (Constructed and validated by S.Yogeshwari and Indu. H, 2018).

- Attitude towards learning Mathematics scale for third grade (Constructed and validated by S.Yogeshwari and Indu. H, 2019).
- Learning style preference inventory for eighth grade students(Constructed and validated by S.Yogeshwari and Indu. H, 2018).
- Learning style preference inventory for third-grade students(Constructed and validated by S.Yogeshwari and Indu. H, 2019).

The tools were validated by finding content validity, face validity, item analysis, and reliability.

PLANNING AND CONDUCT OF STUDY

After constructing the package and finalizing the tools, the study was carried out. Data collection for the study took place from January to March, 2019 for the eighth-grade students, and from January to February, 2020 for the third-grade students. To administer the tools, the researcher first approached the Chief Educational Officer of Nilgiris District for permission and then to the heads of the institutions where the intervention was carried out to seek approval for conducting the research. Following this, the investigator met the relevant school teachers to get their support, ensuring cooperation in the study, and also assessed the students' prior knowledge to gauge their entry behavior.

The investigator then engaged with the participating students, building rapport before administering the tools. General instructions were explained thoroughly, and any doubts the students had were addressed.

Intervention in the eighth grade was given for 37 days. Before that, 3 days were taken for pre and after intervention post-tests was given which lasted for 3 days. And after two weeks delayed post-test was conducted. For third grade, the study intervention period was 20 days, pre and post-tests were conducted for three days each, and a delayed post-test was conducted after two weeks.

It was seen that there were no long absentees or dropouts in the sample selected by the investigator during the intervention. One or two days very few students were absent and for them, extra classes were taken out of class hours to make them learn along with their peer members.

The investigator administered the Achievement test in mathematics, Attitude towards learning mathematics scale, and Learning style inventory guiding the participants whenever doubts arose and solicited their responses. On concluding the tests the investigator collected

all the response sheets, and recorded the duration taken by each student to complete the achievement test.

DATA ANALYSIS

Statistical analysis was done by using different statistical methods specifically Descriptive analysis, Pearson's Correlation analysis, t-test (Independent and paired sample test), and One-way Analysis of Variance.

FINDINGS OF THE STUDY

- Descriptive analysis was conducted for the pre-test and post-test scores obtained from the Achievement test in mathematics and attitude towards learning mathematics of the control and experimental group for the eighth grade and third grade. The calculated values for the measures of central tendency, dispersion, and normality show that the data is not so scattered. Furthermore, the data demonstrates the characteristics of normality.
- Correlation analysis indicated that there was no significant relationship between eighth-grade students' Achievement in mathematics and Attitude towards learning mathematics, however a a significant relation was observed among third-grade students.
- The analysis of pre-test scores revealed that there is no significant difference in the Achievement in mathematics and attitude towards learning mathematics between the control and experimental groups for both eighth-grade and third-grade students.
- The analysis of post-test scores of achievement in mathematics of control and experimental groups of eighth grade revealed no significant differences. In contrast, a significant difference was noted (t-value 9.51) in the post-test scores of achievement in mathematics of control and experimental groups of third-grade students, and the mean scores for the experimental group (15.29) is found to be greater indicating that Vedic mathematics based instruction enhanced the achievement scores of the third-grade students.
- There was no significant difference in the post-test score of attitude towards learning mathematics of the control and experimental group of eighth grade whereas for the third grade, the obtained *t*-value (8.562) shows there was a significant difference and the mean value (47.38) shows that the Vedic mathematics applied in the experimental

group is effective in enhancing the attitude toward learning mathematics of third-grade students.

- The analysis revealed that there was a significant difference in pre-test and post-test scores of achievement in mathematics of the control group (t =16.437,11.055) and the mean value (22.03,11.66) indicates that ALM was also effective in enhancing the achievement scores when the pre and post-intervention scores were compared for eighth and ABL method for third grade.
- The results show that there was a significant difference in pre-test and post-test scores of attitude towards learning mathematics of the control groups (t =2.005, 6.698) of eighth and third grade and the mean post-test value is higher than the pre-test, which means the method of teaching mathematics through the conventional method followed in the control group has a considerable effect on the attitude towards learning mathematics.
- The t-values obtained for the mean pre-test and post-test achievement scores of the eighth-grade and third-grade experimental group were (14.365 and 31.646) which indicates that there is a significant difference. The mean values obtained for the post-test (M=22.03,15.29) show that Vedic mathematics-based instruction helped the experimental group students to get better achievement scores.
- The results of the paired t-test comparing the pre-intervention and post-intervention test scores regarding attitude towards learning mathematics of eighth-grade and third-grade experimental group students reveal a significant difference (t = 5.022,23.145). The mean scores for the post-intervention (M=99.65,47.38) suggest that Vedic mathematics-based instruction has created a positive attitude among both grades towards learning mathematics.
- The computed t-value for the mean scores of post-test and delayed post-test in achievement in mathematics of the control group of eighth-grade students was 6.503. The delayed post-test mean score was higher, indicating that the traditional teaching method had a significant positive effect on their achievement in mathematics. Conversely, no significant differences were found in the third-grade results. Additionally, there was no significant difference between the post-intervention scores and delayed post-test scores for attitudes toward learning mathematics in both the eighth and third grades.

- The paired sample t-test applied for the post-intervention test scores and delayed post-test scores for achievement in mathematics of the experimental group of eighth and third grade showed no significant difference.
- The t-value 2.518 for the post-intervention test and delayed post-intervention attitude scores of experimental group students in eighth grade indicates a significant difference. The mean score (M=96.7) for the delayed post-test attitude score shows a small reduction than the post-intervention mean score(M=99.65) of the experimental group. It reveals that the cessation of the Vedic mathematics-based method shows a decline in the attitude of students towards mathematics, whereas, for the third grade, there is no significant difference.
- Gender wise comparison of the post-test scores of achievement test in mathematics of control and experimental group of girls of eighth grade (t=4.72) shows that there was a significant difference. The mean achievement score of control group girls(M=23.08) is higher than the experimental group (M =17.6), which means, that the traditional method of teaching mathematics was effective for girls. For boys, the t value (3.275) shows that there was a significant difference, and the mean value of the experimental group(M=24.05) was higher than the control group (M=20.35) which indicates that Vedic mathematics-based instruction was effective for boys.
- The computed *t* value for the post-test score of achievement in mathematics of third-grade control and experimental group girls is 7.014 and for boys is 6.965, which indicates that there is a significant difference. The mean value (girls M=16.16, boys M=14.89) of the experimental group is higher than the control group (girls M=11.89, boys M=11.16). This denotes that the Vedic Mathematics-based instruction applied in the third-grade experimental group has a considerable effect on the achievement in mathematics based on gender.
- The post-test t-values for attitudes toward learning mathematics show a significant difference between control and experimental groups for third-grade students by gender. For girls, the t-value is 6.456, and for boys, it is 6.346. The experimental group had higher mean scores (girls: M = 50.36, boys: M = 46.02) than the control group (girls: M = 40.15, boys: M = 35.72), indicating that Vedic Mathematics-based instruction positively impacted students' attitudes. No significant gender-based difference was found for eighth-grade students.

- The post-test t-values for achievement in mathematics show a significant difference between control and experimental groups in both government-aided and private schools. In government-aided schools, the control group (M = 12.07) outperformed the experimental group (M = 5.5) with a t-value of 6.878, indicating the traditional teaching method was more effective. Conversely, in private schools, the experimental group (M = 15.08) outscored the control group (M = 11.25) with a t-value of 6.662, demonstrating that Vedic Mathematics improved achievement in mathematics of third-grade students. No significant difference was observed for eighth-grade students.
- The t-value 2.782 for the post-test scores on attitudes toward learning mathematics of eighth grade in government-aided schools indicates a significant difference. The experimental group (M = 103.6) scored higher than the control group (M = 95.38), suggesting that Vedic Mathematics-based instruction improved students' attitudes toward learning. No significant difference was observed among private school students.
- In third grade, the experimental group in government-aided schools had a significantly higher post-test score (M = 47.78, t = 8.031) compared to the control group (M = 36.60). Similarly, in private schools, the experimental group (M = 46.98, t = 3.715) has a higher mean score than the control group (M = 40.93). This demonstrates that Vedic Mathematics has effectively improved third graders' attitudes toward learning mathematics in both government-aided and private schools.
- The *F* value (1.105,0.228) of the eighth and third grade obtained for the ANOVA shows that there is no significance which indicates that Vedic mathematics-based instruction are effective for students belonging to all the three learning styles namely visual, auditory, and kinesthetic.
- The t value obtained for Computation speed scores of the Control and Experimental Group for the VIII (t =4.423) and III Grade (t=5.680), shows a significant difference and the mean value of the experimental group of both grades(M=41.95,42.82) is higher than the mean value of the control group (M= 55.31,58.25) which indicates that the students taught through Vedic mathematics have enhanced computational speed.
- A qualitative analysis was done by conducting a semi-structured interview with both the teachers and students. The responses suggest that teachers and students perceive

Vedic mathematics as advantageous in various significant aspects, particularly in fostering student engagement and enhancing mathematical skills.

IMPLICATIONS

The substantial difference in mean post-test scores between the control and experimental groups of primary(third-grade) students indicates that Vedic Mathematics instruction can be a powerful teaching strategy for improving mathematical performance at the lower primary level.

The significant differences in mean post-test and delayed post-test scores among the control group of eighth-grade students further validate the effectiveness of traditional instructional methods, while also highlighting the potential for ongoing improvement through Vedic Mathematics.

Additionally, the significant differences in the experimental group's post-test scores regarding their attitudes towards mathematics suggest that Vedic Mathematics instruction enhances not only mathematical abilities but also fosters a more positive attitude towards the subject

RECOMMENDATION

- Given the positive impact on both achievement in mathematics and attitude towards learning, it is recommended that Vedic Mathematics be integrated into the regular curriculum for primary and middle school students. This integration could be phased in gradually, starting with specific mathematical concepts where Vedic methods show the most promise.
- Teachers should be provided with professional development opportunities to become proficient in Vedic Mathematics techniques. This training should include practical workshops, instructional resources, and ongoing support to ensure that teachers are confident and effective in delivering Vedic Mathematics instruction
- To better understand the long-term impact of Vedic Mathematics instruction, longitudinal studies should be conducted. These studies could track students over several years to assess the sustained benefits of Vedic Mathematics and its influence on later academic achievement and career choices.
- Educational publishers and curriculum developers should consider creating and distributing high-quality learning materials that incorporate Vedic Mathematics. These

resources should be age-appropriate, engaging, and aligned with the existing curriculum standards

- Educational policymakers should consider the findings of this study when developing mathematics education policies.

CONCLUSION

The study's findings shed light on the fact that Vedic mathematics helps students develop a positive attitude toward learning Mathematics. It also proves that Vedic mathematics helps improve students' achievement in mathematics, suggesting that it is better to implement a new method from the lower-level classes for better learning.

By introducing Vedic mathematics alongside traditional methods from an early stage, students can develop greater confidence, speed, and accuracy in their calculations, making mathematics a more engaging and interesting subject.

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